BELLCOMM, INC.
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B69 05070

SUBJECT: Orbital ΔV Capability of SOH Launch Vehicle When Off Loading Payload Case - 105-3

DATE: May 20, 1969

FROM: J. J. Schoch

MEMORANDUM FOR FILE

Introduction

The stage and one half (SOH) launch vehicle is a space shuttle which carries about 90% of its propellant in two expendable tanks. The rest is included in the so-called core that also contains the engines, the crew systems, and, for the return trip, the recovery and heat protection systems. In most configuration studies the vehicle is sized to carry a nominal payload weight to low earth orbit. If some or all of that payload were offloaded, then, upon reaching orbital conditions after launching with a normal propellant loading, some of that propellant would still be available for orbital maneuvering. In the following the relationship between payload and orbital ΔV is evaluated.

Analyses and Results

The calculations are based on the SOH vehicle and weight scaling model given in Reference 1.* Computations were carried out for 3 vehicles having nominal payloads of 10,000 lbs, 25,000 lbs, and 50,000 lbs to 100 nmi easterly orbit respectively. In all three cases a core fixed weight of 20,000 lbs was assumed (this does not include heat protection systems, deorbit propellant, and other core systems which scale as in Reference 1). Emphasis here is on the relative performance capabilities of the three different payload class vehicles; the absolute values of ΔV and payload are sensitive to the fixed weight and scaling assumptions.

The results are shown graphically on Figure 1 in which the ΔV capability is plotted versus the payload. It may be seen that the 10,000 lb payload vehicle provides a ΔV capability up to 2,000 ft/sec. This ΔV capability increases to almost 4,000 and over 5,500 ft/sec for the 25,000 and 50,000 lb payload launch vehicle respectively.

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*The scaling laws used in Reference 1 apply to vehicles whose internal payload containers are sized to payload densities of about 10-20 lbs/ft^3; they are not valid for core vehicles carrying a large volume of low density internal payload such as liquid hydrogen. A vehicle which is designed to carry 50,000 lbs of hydrogen internally would have considerably less on-orbit maneuvering capability than indicated herein.

For comparison purposes the ΔV capability of these same vehicles was computed for the case of an auxiliary propellant tank being substituted for the off-loaded payload and that propellant used to do the orbital maneuvering. It was found that for a tank inert fraction of slightly less than .1 the ΔV capability is about the same as for the case given in Figure 1.

J. J. Schoch

1013-JJS-nma

Attachment
Reference
Figure 1

REFERENCE

"Effects of SOH Sizing on Payload/Gross Weight, and Performance Sensitivity to Core Inert Weights," by D. E. Cassidy and J. J. Schoch, Technical Memorandum 69-1013-3, March 13, 1969.

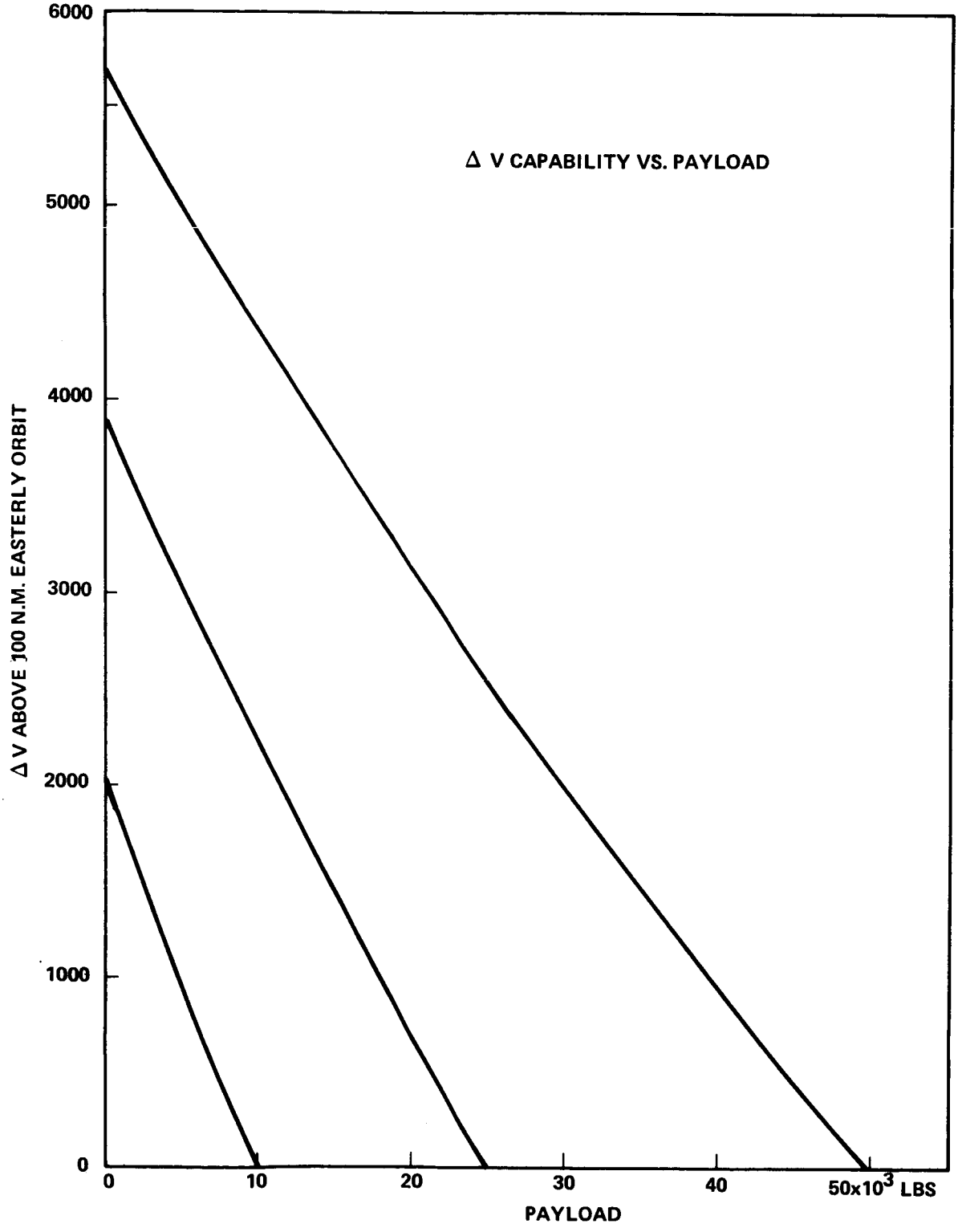
Δ V CAPABILITY VS. PAYLOAD
Δ V ABOVE 100 N.M. EASTERLY ORBIT
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50x10^3 LBS
PAYLOAD

FIGURE 1

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